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Bell's Outdoor and Indoor Experimental Arithmetics

Third Year's Course
(Standard V)

BELL'S

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Outdoor and Indoor Experimental Arithmetics

BY

HERBERT H. GOODACRE, F.R.G.S.
HEADMASTER

AND

EDW. F. HOLMES, CHARLES F. NOBLE
PERCY STEER
ASSISTANT MASTERS, SOUTH PARK SCHOOL, ILFORD

THIRD YEAR'S COURSE (Standard V.)

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FOREWORD.

The aim of this series is to lead children—by experiment, inference, comparison and contrast—to form a real conception of Length, Area, Weight and Volume.

Each experiment has a definite end in view; either the establishment of an abstract principle, or the practical proof of a theoretical calculation.

The exercises are intended to be taken at times specially set apart for practical work, as it is generally found to be inconvenient to combine practical and theoretical exercises in the same lesson.

They provide, moreover, an interesting and ample course of hand and eye training, which, preceding the theory lesson as it should, has the effect of stimulating the child's activities, and associating in his mind the world of things with the world of ideas.

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OUTDOOR AND INDOOR EXPERIMENTAL ARITHMETIC.

THIRD YEAR'S COURSE.

SECTION I.—LENGTH.

1. The Chain.

(*a*) Find the line marked on the playground which is 1 *chain* in length.

(*b*) By means of your tape-measure or yard-stick, find how many yards are contained in 1 chain.

(*c*) Enter the following statements in your note-book and complete them:

(i) 1 chain = yards.
(ii) ∴ 1 chain = feet.
(iii) Also, 1 chain = poles.

2. Diagram shewing Chain, Poles and Yards.

In your permanent note-books make a diagram shewing 1 *chain* divided into *poles*, and 1 pole subdivided into *yards*. (Scale $\frac{1}{4}''$ to 1 yard.)

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3. Finding Length of Stride.

(*a*) From the line marked on the playground, walk 10 ordinary strides.

(*b*) Mark your halting position (heel) with a piece of chalk.

(*c*) By means of the tape-measure, find the exact length of this distance.

(*d*) Calculate the length of 1 stride.

4. Striding a Distance.

(*a*) Knowing the length of your stride (found in Ex. 3), calculate the number of strides required to make a distance of 2 chains.

(*b*) From the line marked on the playground, make the number of strides (found in Ex. 4 (*a*)).

Mark your halting position (heel) with a piece of chalk.

(*c*) By means of your tape-measure, find the exact distance you have walked.

(*d*) Make the following table in your note-book and complete the same :

	Distance to be Stepped.	From Ex.3(*a*)	From Ex. 4 (*a*)	From Ex. 4 (*c*)	Amount of Error.
		Length of Stride.	No. of Strides to be taken.	Actual Distance.	
e.g.	2 chains =44 yds.	2 ft. 7 ins.	51+3 ins. over.	48 yds. 2 ft. 8 ins. or 2 ch. 4 yds. 2 ft. 8 ins.	4 yds. 2 ft. 8 ins.

5. Exercise to give some idea of Longer Distances.

A distance of 10 chains will be marked out. Endeavour to remember this length.

Write answers to the following questions :

(*a*) How many yards are there in 10 chains ?

(*b*) ,, ,, ,, ,, 1 mile ?

(*c*) How many times are 10 chains contained in 1 mile ?

(*d*) What is the relation between 1 furlong and 1 mile ?

(*e*) What relation therefore can you find between 10 chains and 1 furlong ?

(*f*) How many distances of 10 chains each will be required to make 1 mile ?

6. Estimating Distances in Metres.

(*a*) Estimate, in metres, the distances of children from the line marked on the playground.

(*b*) With your tape-measure or metre-stick, find the exact distance.

(*c*) Enter results and calculate your error.

	Scholar.	Estimated Distance.	Actual Distance.	Amount of Error.
e.g.	*A*	8 metres.	9·1 metres.	1·1 metres.
	B			
	C			

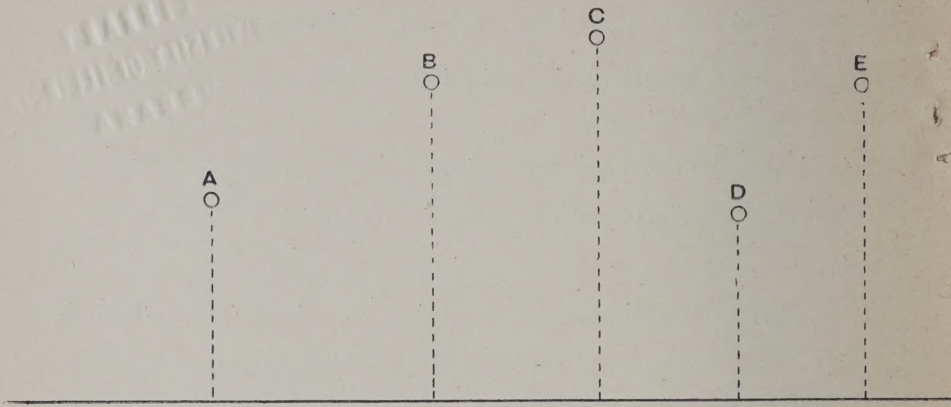

FIG. 1.

7. Estimations in Yards.

(*a*) Estimate, in yards, the distances between pairs of children placed in positions by your teacher.

(*b*) Find the actual distance between them by means of your yard-stick or tape-measure.

(*c*) Record results and complete the following table :

	Pair.	Estimated Distance.	Actual Distance.	Amount of Error.
e.g.	*AB*	10 yds.	9 yds. 0 ft. 4 ins.	2 ft. 8 ins.
	CD			
	EF			
	GH			
			TOTAL ERROR =	

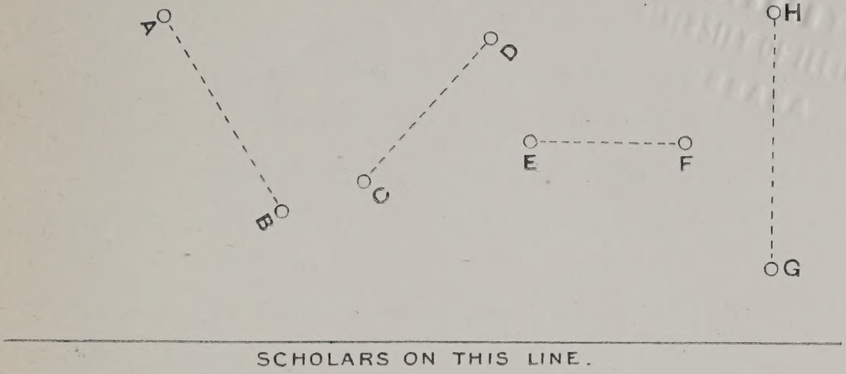

FIG. 2.

8. Comparison of the Pole and Dekametre.

(*a*) By placing the heel of one foot against the toe of the other, find how many lengths of your foot are required to make a distance of 1 pole.

(*b*) In a similar manner find out the number of foot-lengths required to make a distance of 1 dekametre (1 Dm.).

(*c*) Comparing these two results, write down the relation between a pole and a dekametre.

9. Comparison of the Pole and Five Metres.

(*a*) Write down the length of 1 pole in yards and feet.

(*b*) Find the line marked on the playground which is 5 metres in length. With your tape-measure carefully find its length in yards, feet and inches.

(*c*) Which is the greater, 5 metres or 1 pole, and by how much ?

10. The Decimetre and its Parts

(*a*) Draw a line 2 dm. (decimetres) in length.

(*b*) Divide one decimetre into 10 equal parts.

(*c*) Write answers to the following questions :

- (i) How many of these small divisions are there in 1 dm. ?
- (ii) How many decimetres are there in 1 metre ?
- (iii) How many small divisions are there in 1 metre ?
- (iv) What part of 1 metre is one small division ?

(*d*) Write down the correct name of this small division.

11. Comparison of Inches and Centimetres.

(*a*) Draw a line 4 ins. long.

(*b*) Mark off centimetres along its length.

(*c*) Calculate about how many centimetres (cms.) make a length of 1 in.

12. Estimation of Length—Two Dimensions.

(*a*) Estimate the number of centimetres in the length and breadth of square and rectangular pieces of cardboard supplied to you.

(*b*) Measure the same with your ruler in centimetres and tenths.

(*c*) Record results thus:

Card.	Exercise.	Length.	Breadth.
M	(i) Estimated at		
	(ii) ACTUAL MEASUREMENTS		
	(iii) Amount of Error		

13. Estimation of Length—Three Dimensions.

(*a*) Calculate to the nearest centimetre, the length, breadth and depth of the boxes given to you.

(*b*) Measure the dimensions of the boxes, as in Ex. 12, enter results, and complete the following table:

No. of Box.	Exercise.	Length.	Breadth.	Depth.
	(i) Estimated at			
	(ii) ACTUAL MEASUREMENTS			
	(iii) Amount of Error			

14. Estimations—Inches and Centimetres.

Estimate in *inches*, and also in *centimetres*, the lengths of the following articles:

To be estimated.	I. English Measurements			II. Metric Measurements		
	Estimated at	Actual Measurement.	Amount of Error.	Estimated at	Actual Measurement.	Amount of Error.
Reading-book—length of						
,, ,, —width ,,						
Lead Pencil —length of						
Ruler ,, ,,						
,, —width ,,						
Pen tray —length ,,						
,, —width ,,						
,, —depth ,,						
		TOTAL ERROR =			TOTAL ERROR =	

15. Estimations—Revision Exercise.

(*a*) With scissors cut off strips of paper (about ½ in. wide) as nearly as you can to the following lengths. (Indicate the length on each strip, as you proceed.)

(i) 7¾ in.
(ii) 3·5 in.
(iii) 4½ in.
(iv) 6 cm.
(v) 1·4 dm.
(vi) 2·5 cm.

(*b*) Now measure carefully each of your strips.

(*c*) Make a double table as above, enter results and complete the same.

16. Graph of Height.

(*a*) Measure your height at regular intervals, and record your results as shewn by the graph.

(*b*) Insert also the average height of the class as indicated.

(*c*) By how much does your height differ from the average height ?

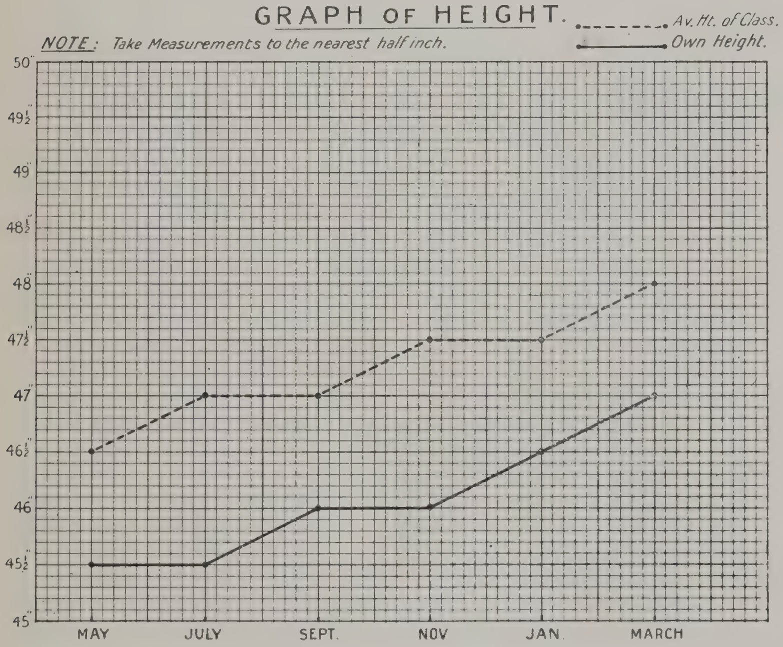

FIG. 3.

SECTION II.—AREA.

17. Area of Squares.

(*a*) Construct and cut out squares of paper or cardboard with sides 2½ ins. 3½ ins. and 6½ ins. long respectively.

(*b*) Calculate their areas in *square half-inches*, and convert your answer into square inches.

(*c*) Arrange your work thus:

	Length of Side of Square.	Area in Sq. Half-Inches.	Area in Sq. Inches.
e.g.	3½ ins.	$7 \times 7 = 49$	$\frac{49}{4} = 12\frac{1}{4}$ sq. ins.

18. Area of a Rectangle.

(*a*) Construct a rectangle 6½ ins. long and 4½ ins. wide.

(*b*) Calculate its area in square inches.

19. Covering a Rectangular Surface.

(*a*) Lay down on the class-room floor or playground a rectangle 3 ft. 3 ins. long and 1 ft. 6 ins. wide, and calculate its area.

(*b*) Find how many tiles of the size you made in Ex. 18 (*i.e.* 6½ ins. × 4½ ins.) would be required to cover this space exactly.

(*c*) Test your results by laying your cards in position over the large rectangle until it is exactly covered.

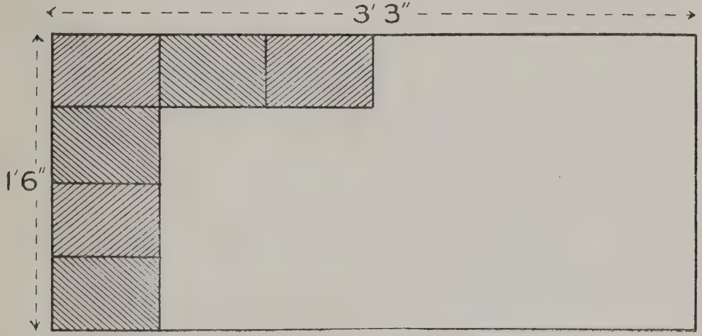

FIG. 4.

20. The Two-Inch and Five-Centimetre Squares.

(*a*) Construct a square with sides 2 ins. long, and divide it into inch squares (Fig. 5).

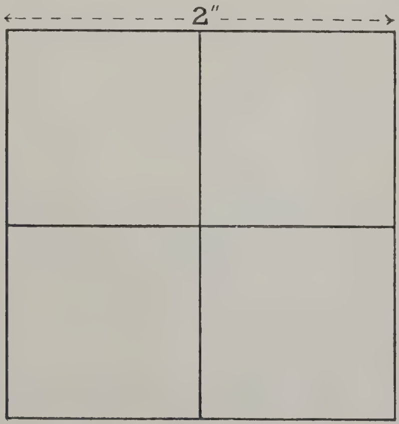

FIG. 5.

(*b*) Make a square with side 5 cms. long, and divide it into sq. cms. (Fig. 6).

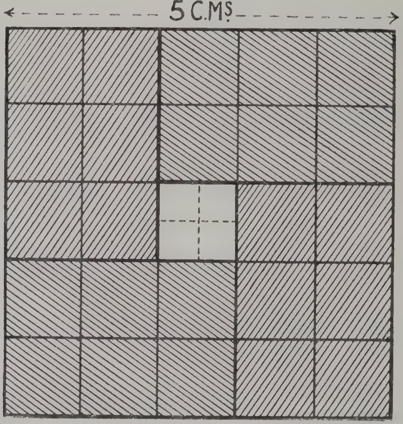

FIG. 6.

(*c*) Cut both squares out and lay them one over the other.

(*d*) What do you notice about their size ?

(*e*) How many sq. cms. are about equal to 4 sq. ins. ?

(*f*) How many sq. cms. are about equal to 1 sq. in. ?

(*g*) Mark off the 5 cm. square into rectangles, each containing 6 sq. cms., as shewn in the diagram (Fig. 6), and leave the odd sq. cm. in the centre.

(*h*) What part of this sq. cm. must go with each rectangle to make it equal to 1 sq. in. ?

21. The Square Decimetre.

(*a*) Construct and cut out a square of 10 cms. side, and write down its area in sq. cms.

(*b*) Measure carefully the length of its side in inches, and calculate its area in sq. inches.

(*c*) Write down the nearest number of sq. ins. that make a sq. dm.

22. The Square Metre.

(*a*) Lay down a sq. metre in the playground or hall.

(*b*) How many *square decimetres* will cover it ?

(*c*) Measure the length of its side in inches and tenths, and calculate its area in sq. inches.

(*d*) From your answers find how many sq. inches make a sq. decimetre, and compare your answer with Ex. 21 (*c*).

23. The Area of a Flagstone.

(*a*) Measure the dimensions of a flagstone in inches, and calculate its area.

(*b*) Now take its dimensions in cms., and calculate its area in sq. cms.

(*c*) Find how many sq. cms. are equal to 1 sq. inch.

(*d*) Compare your answer with Ex. 20 (*f*).

24. Number of Flagstones required to pave a Path.

(*a*) Measure the width of the path from kerb to wall (Fig. 7).

(*b*) Mark off along the pavement a distance of 20 yards, and find the area.

(*c*) From the area of a flagstone found in Ex. 23 (*a*), find the number of flagstones required to pave this distance.

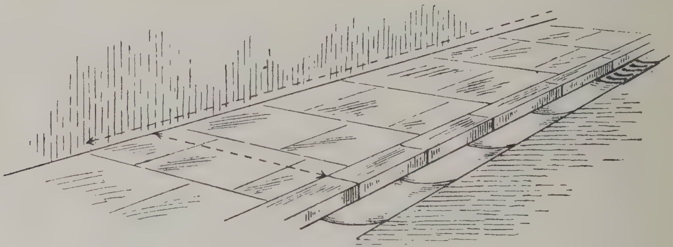

FIG. 7.

25. Number of Square Tiles required to tile a Hearth.

(*a*) Measure the dimensions (in inches) of the tile supplied to you, and calculate its area.

(*b*) Take the dimensions of the class-room hearth, or of a space marked on the floor.

(*c*) Find the number of tiles required to tile the hearth, or marked space.

26. Estimating Dimensions.

(*a*) Estimate in inches the dimensions of the piece of cardboard supplied to you, and calculate its area.

(*b*) Taking your estimated dimensions, make a drawing to scale ($\frac{1}{2}$, $\frac{1}{3}$ or $\frac{1}{4}$ size).

(*c*) Now measure the cardboard carefully, in inches and tenths, and calculate its area.

(*d*) Find the amount of your error.

(*e*) Also draw it to scale as shewn in Fig. 8.

(*f*) If possible, shade the amount of your error as shewn by your drawing.

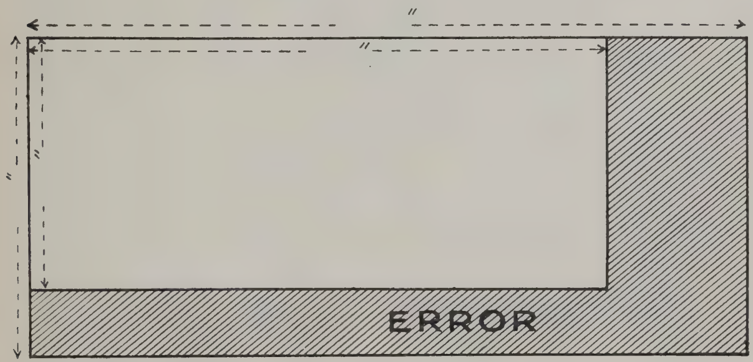

Fig. 8.

27. Finding Total Surface of a Rectangular Tin or Wooden Box.

(*a*) Measure carefully the height of the tin or box supplied to you.

(*b*) Cut a piece of thin paper exactly this width, and fold it round the tin as shewn in the diagram (Fig. 9).

(*c*) Place a mark where the paper meets, and fold at right angles.

(*d*) Cut down the fold, and calculate the area of the paper that exactly surrounds the tin or box.

(*e*) Cut another piece of paper the exact size of the bottom, or top, and find its area.

(*f*) Find the total surface.

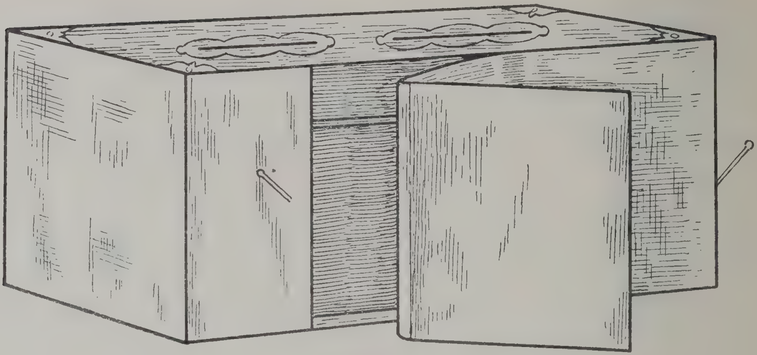

Fig. 9.

28. The Square Dekametre.

(*a*) Measure with your metre-rod the length of the side of this figure, laid down in the playground.

(*b*) Calculate its area in sq. metres.

(*c*) Next, measure its dimensions in yards, as nearly as you can.

(*d*) Find how many sq. yds. are about equal to a sq. dekametre (sq. Dm.).

(*e*) Arrange your answers thus :

Unit.	Length of Side.	Area of Figure (*i.e.* Sq. Dm.).
(i) Metre (ii) Yard		

……………sq. yards make 1 Square Dekametre.

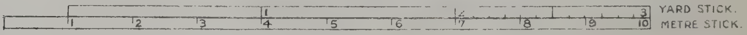

Fig. 10.

29. The Square Pole and Square Dekametre.

(*a*) Measure the dimensions of the sq. pole in metres and decimetres, and calculate its area as nearly as you can in sq. metres.

(*b*) Find about how many sq. poles make 1 sq. Dm.

(*c*) Arrange your answer thus :

Length of Side of Sq. Pole.	Area of Sq. Pole.	Area of Sq. Dm.	About Number of Sq. Poles in 1 Sq. Dm.
metres.	sq. metres.	sq. metres.	

30. The Square Metre and Square Pole.

(*a*) Measure the dimensions of the sq. pole in metres and decimetres, and calculate its area in sq. metres.

(*b*) Write down the number of sq. metres that are about equal to 1 square pole.

31. Estimating Dimensions of Room.

(*a*) *Estimate* the length and width of your class-room.

(*b*) From your estimations calculate its area.

(*c*) Carefully *measure* its dimensions with a tape-measure, and calculate its actual area.

(*d*) Find the amount of your error.

(*e*) Record results thus :

Exercise.	Length.	Width.	Area.
(i) Estimation (ii) Measurement			
		Amount of Error =	

32. Calculating Number of Wood Blocks required to cover Floor.

(*a*) Find the area of the wood block given to you.

(*b*) From the area of the floor (found in Ex. 31 (*c*)), find the number of blocks required to cover it.

33. Properties of Rectangles and their Diagonals.

(*a*) Construct a rectangle 5·7 ins. and 3·8 ins. wide, and find its area.

(*b*) Draw its diagonals, as shewn in Fig. 11, and measure them.

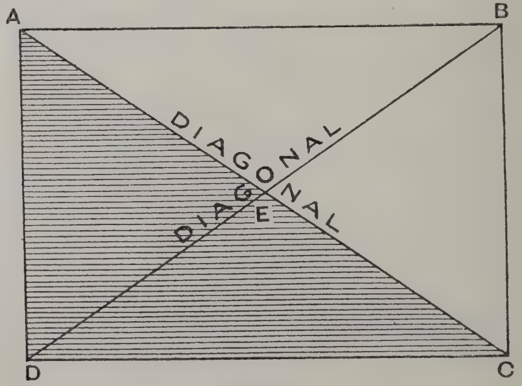

Fig. 11.

(*c*) Write down what you have discovered about the lengths of the diagonals of a rectangle.

(*d*) Now measure the distance from the point *E* to each of the corners.

(*e*) Write down what you know about the position of *E* with regard to the points *A*, *B*, *C* and *D*.

(*f*) Cut out the rectangle, and also cut along the diagonal *AC*.

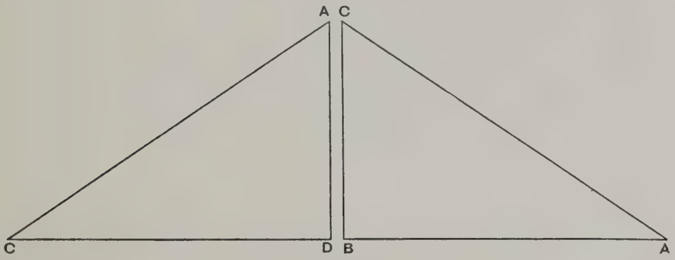

FIG. 12.

(*g*) Lay the two triangles side by side as shewn in Fig. 12.

(*h*) Now place them exactly one over the other.

(*i*) What do you know about their sizes ?

(*j*) How does the diagonal of a rectangle divide it ?

(*k*) What is the area of each triangle ?

(*l*) What *kind* of triangles are they ?

34. The Properties of a Square and its Diagonals.

(*a*) Construct a square with side $4\frac{3}{8}$ ins. long.

(*b*) Draw the diagonals and measure them.

(*c*) What do you know about their lengths ?

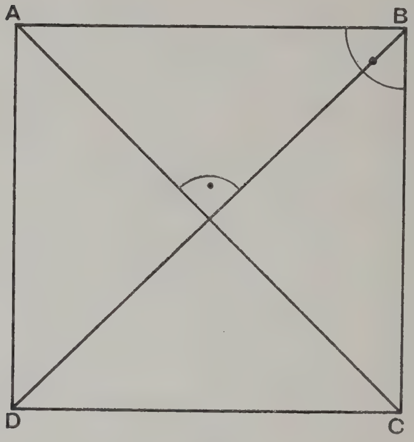

Fig. 13.

(*d*) Measure with your protractor or set-square the angles marked in the above diagram (Fig. 13).

(*e*) What do you know about the size of the angles of a square ?

(*f*) Write down what you have discovered concerning the size of the angles formed by the intersecting diagonals.

(*g*) Now cut along the diagonal *AC*.

(*h*) Place one triangle over the other.

What do you notice about their sizes ?

(*i*) With your protractor measure all the small angles.

What have you discovered about them ?

(*j*) How does the diagonal divide a square ?

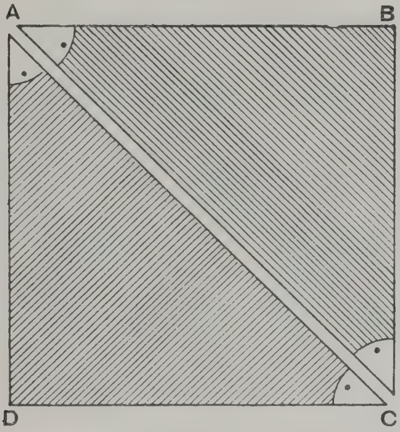

FIG. 14.

SECTION III.—VOLUME AND CAPACITY.

35. Volume by Measuring Contents.

(*a*) Take the small rectangular box given to you, and carefully fill it with sand.

(*b*) Empty the sand into the graduated glass (Fig. 15), and read off its volume in cubic inches.

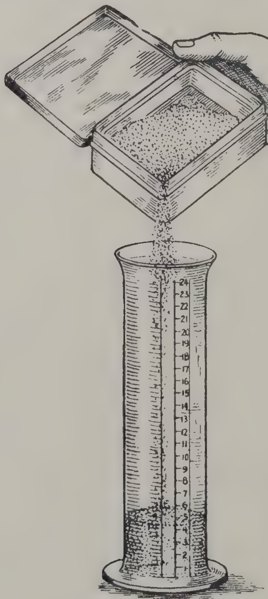

FIG. 15.

Enter your results as shewn below.

(*c*) Find the inside measurements of the box, and calculate its volume in cubic inches. Write your result.

(*d*) Compare the two results you have obtained.

If the difference is great, check the volume and your measurements, and so find the error.

Example. (i) Volume of sand in box = 21 cu. ins.

(ii) Length of box = $2\frac{1}{2}$ ins.
Width ,, = 2 ins.
Depth ,, = 4 ins.
∴ Volume of box = 20 cu. ins.

Difference = 1 cu. in.

36. A Rectangular Box—Volume of Wood.

(*a*) Carefully measure the outside dimensions of the rectangular wooden box given to you.

Make a table in your note-book as shewn below, and enter the three measurements.

(*b*) From these measurements calculate the external (or outside) volume of the box.

(*c*) Fill your box with sand. Empty it into the measuring-glass, and find how many cu. ins. it contains.

(*d*) From these results find the volume of wood in the box.

	Wooden Box.	Length.	Breadth.	Depth.	Volume.
e.g.	Outside Measurements	$5\frac{1}{2}$ ins.	4 ins.	3 ins.	66 cu. ins.
	Volume of Sand	—	—	—	50 cu. ins.
	Volume of Wood	—	—	—	16 cu. ins.

37. Volume of Box in Cubic Centimetres.

(*a*) Repeat the previous exercise, but take your measurements in centimetres, thus finding the volume of the same box in cubic centimetres.

(*b*) Enter your results as before.

38. Cubic Decimetre and Cubic Centimetres.

(*a*) From cardboard construct a tray (Fig. 16) 10 cms. long, 10 cms. wide and 1 cm. deep.

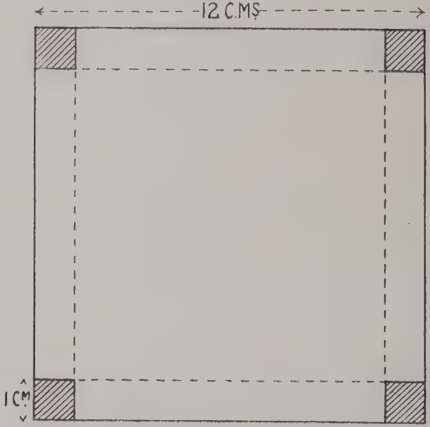

FIG. 16.

(*b*) Cut out from soap as many centimetre cubes as you can.

(*c*) As these are gathered into one tray, find how many a tray will hold (Fig. 17).

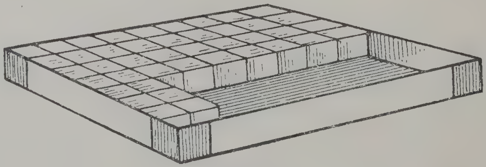

FIG. 17

(i) How many are there in each row ?

(ii) How many rows are there ?

(iii) Hence how many cubes are there in the tray ?

(*d*) How many of these trays would fill a cubic decimetre ? (Second Year's Course, Ex. 33.)

(*e*) How many cubic centimetres will the cubic decimetre hold ?

(*f*) Measure in centimetres the length, breadth and depth of the cubic decimetre, and thus calculate its volume in ccs. Compare this result with that obtained in (*e*).

(*g*) Write your result :

1 cubic decimetre =   cubic centimetres.

39. Volume by Displacement.

(*a*) Fill the graduated glass with water—to any known mark, *e.g.* 10 cu. ins.

Also take the reading in ccs.

(*b*) Place your 1 in. wooden cube into the water and press it below the surface by means of a knitting needle (Fig. 18).

(*c*) How much has the water risen ?

What does this rise represent ?

(*d*) Rule columns as shewn on page 28, and enter your results.

(*e*) Then take any other small objects, *e.g.* a stone, large marble, iron bolt and nut, piece of iron. Find their volumes in the same manner in cu. ins. and ccs., and enter results.

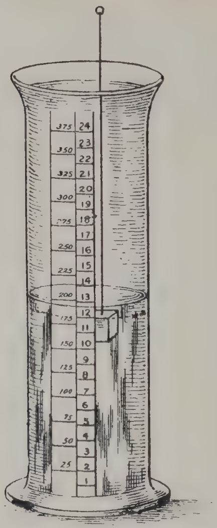

FIG. 18.

Object.	Readings from Graduated Jar.		Volume.
	Before.	After.	
(1) 1 in. cube	10 cu. ins.	11 cu. ins.	1 cu. in.
,,	ccs.	ccs.	ccs.
(2) Stone	cu. ins.	cu. ins.	cu. ins.
,,	ccs.	ccs.	ccs.

40. Cubic Inches and Cubic Centimetres.

(*a*) Construct two cardboard cubes, one with sides 2 ins. long and the other with sides 5 cm. long.

(*b*) Compare the sizes of these two cubes.

(i) Can you place one within the other ?

(ii) What conclusion can you draw with regard to their sizes ?

(*c*) Rule columns as shewn on page 30; calculate and enter the volumes of the two cubes.

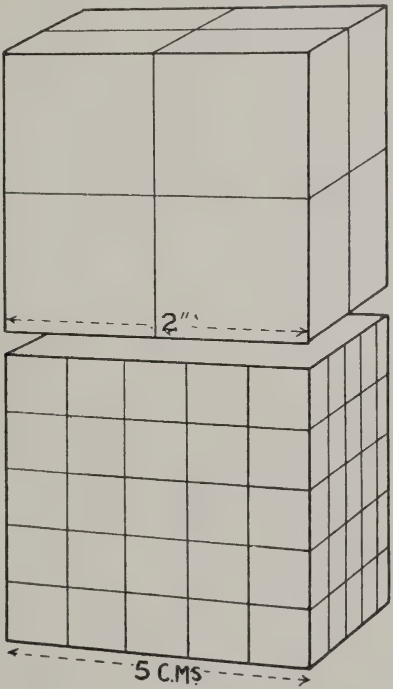

FIG 19.

(*d*) Pour into a graduated measuring cylinder any number of cu. ins. of sand or water. Take the reading of the contents in cu. ins. and also in ccs.

Repeat with several volumes of sand, and enter results.

(*e*) Refer to Exs. 36, 37 and 39, where you have results in both ccs. and cu. ins.

Enter these pairs of equal volumes in your present table.

(*f*) Now complete the third column in each case, thus finding the number of ccs. contained in 1 cu. in.

(*g*) Add all your results together. Divide by the number of results, thus finding your average result.

Object, etc.	Volume in Cubic Inches.	Volume in Cubic Centimetres.	$\frac{\text{Ccs.}}{\text{Cu. ins.}}$ = ccs. in 1 cu. in.
(1) 2 in. and 5 cm. cubes	8	125	$\frac{125}{8} = 15\frac{5}{8}$
(2) Graduated glass -	3	46	$\frac{46}{3} = 15\frac{1}{3}$
Results from Ex. 36 -		—	
,, ,, 37 -	—		
1 in. cube (Ex. 39) -			
		TOTAL =	
		AVERAGE =	

SECTION IV.—WEIGHT.

41. Exercises in Weighing.

(*a*) Take three bags. Weigh out 250 grams of sand and place it in the first. In the second, place 100 grams, and in the third, 50 grams.

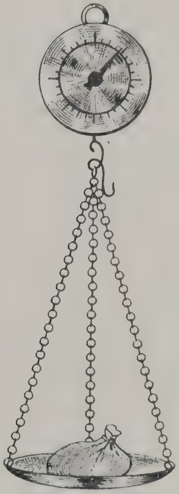

FIG. 20.

(*b*) Place in turn, each of the bags upon the spring balance, and read off, as accurately as you can, the weight in ounces.

(*c*) Record your results thus:

Metric Weight.	Same Weight in Ounces.
(1) 250 grams	ozs.
(2) 100 ,,	,,
(3) 50 ,,	,,

42. Graph shewing Grams and Ounces.

(*a*) Make a graph from the results you have obtained, to shew the relation between grams and ounces.

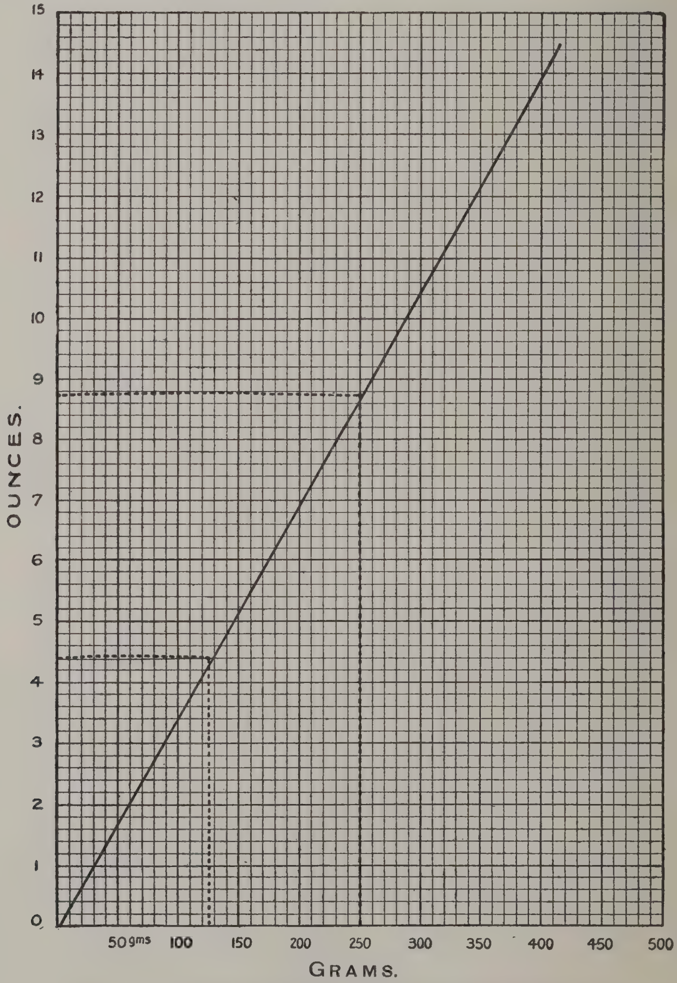

FIG. 21.—Graph shewing Relation between Grams and Ounces.

(*b*) By its aid find how many ounces weigh as much as
(i) 200 grams. (ii) 150 grams.

43. Application of the Graph.

(*a*) *Estimate*, in grams, the weight of the object given you.

(*b*) From your graph find the number of ounces which corresponds to your estimated weight.

(*c*) Repeat the above exercises with other articles.

(*d*) As each object is weighed, enter its correct weight (in ounces) in a table as shewn.

(*e*) From your graph now find the number of grams which corresponds to this correct weight.

(*f*) Complete the table.

	Object.	Estimated Weight in Grams.	Weight in Ounces from Graph.	Correct Weight in Ounces.	Correct Weight in Grams from Graph.	Amount of Error in Grams.
e.g.	Flower-pot	210 grams	7 ozs.	6 ozs.	180 grams	30 grams

44. Relation between Grams and Cubic Centimetres.

(*a*) Watch carefully while 1 kilogram of water is weighed in a litre measure. How many grams are there in 1 kilogram ?

(*b*) What is the capacity of the vessel which is used ?

(*c*) How many ccs. does it hold ?

(*d*) Complete the following statements :

(i) 1 kilogram = grams.

(ii) Volume of water = 1 litre
= ccs.
(iii) ∴ grams of water = ccs.
(iv) ∴ 1 gram of water = ccs.

45. The Weight (in Pounds) of a Gallon of Water.

(*a*) Make columns, as shewn below, and in the first one enter the weight of a bucket.

(*b*) When 1 gallon of water has been placed in the bucket, lift the same, and so estimate the weight of the whole, in pounds.

(*c*) Enter other results as the experiment proceeds, and complete the table.

	Weight of Bucket.	Estimated Weight (Bucket and Water).	Estimated Weight of Water.	Actual Weight (Bucket and Water).	Actual Weight of Water.	Amount of Error.
e.g.	$2\frac{1}{2}$ lbs.	14 lbs.	$11\frac{1}{2}$ lbs.	12 lbs.	$9\frac{1}{2}$ lbs.	2 lbs.

1 gallon of water weighs..............lbs.

46. Relation between the Weight of a Gallon of Water and a Kilogram.

(*a*) To find the weight (in kilograms) of 1 gallon of water, enter the following statements in your note-book and complete:

(i) 1 gallon = pints.
(ii) 1 litre = pints (found in Second Year, Ex. 36).

(iii) 1 litre = kilogram.
(iv) ∴ $1\frac{3}{4}$ pints = kilogram.
(v) ∴ 1 pint = kilogram.
(vi) ∴ 8 pints / 1 gallon = kilogram.

(*b*) The weight of 1 gallon of water will be found by means of the spring balance.

Enter this result, and compare with that obtained above.

47. Graph of Weight.

(*a*) Take your weight in stones and lbs. at regular intervals, and record on a graph.

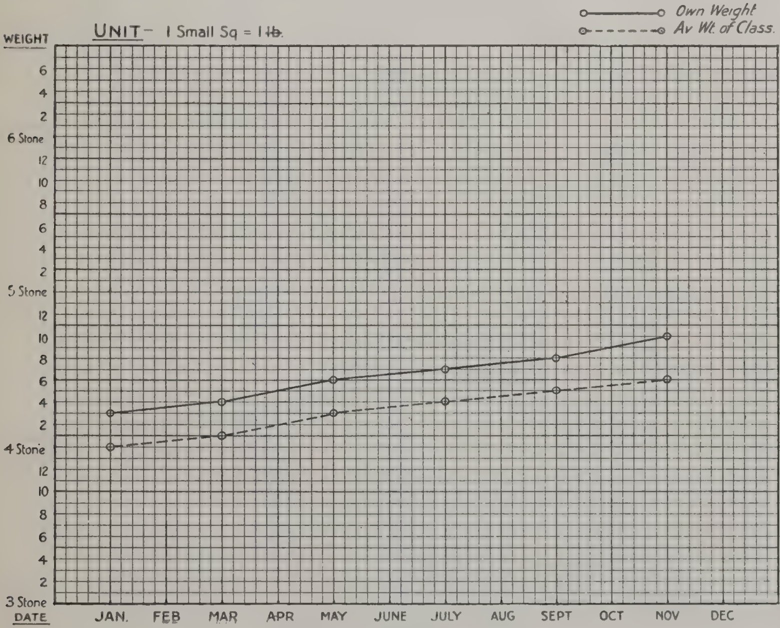

FIG. 22.—Graph of Weight.

(*b*) Insert the graph shewing the average weight of the class.

(*c*) By how much does your weight differ from the average weight ?

SECTION V.—TIME.

48. Observations of Shadows.

(*a*) Place a pole perpendicularly into the ground so that exactly 6 feet project.

(*b*) Observe the shadow which the pole casts on a bright day at 9 a.m., 12 noon and 3 p.m. Measure the length of the shadow at each time.

(*c*) By means of the compass find the direction of the shadow, and that of the sun (Fig. 23).

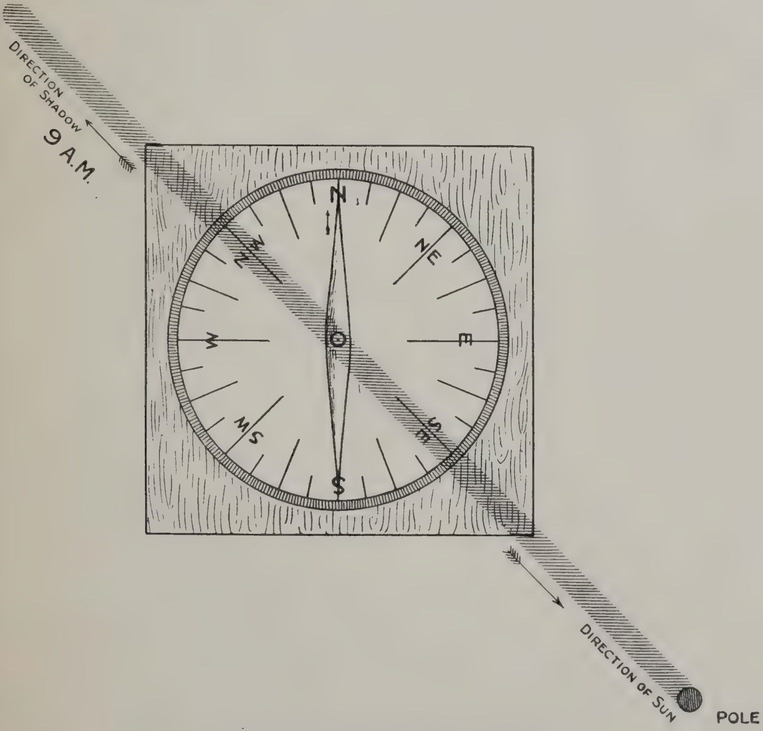

FIG. 23.—Direction of Sun's Shadow at 9 a.m.

(*d*) Record results thus :

	Length of Pole.	Time of Observation.	Length of Shadow.	Direction of Shadow.	Direction of Sun.
e.g.	6 ft.	9 a.m.	5 ft. 10 ins.		

(*e*) Now write answers to the following questions :

(i) At what time is the shadow shortest ?

(ii) At what time is the shadow longest ?

(iii) How does the shadow at 9 a.m. differ from that at 3 p.m. ?

49. Angular Height of Sun.

(*a*) Make three drawings to scale, on squared paper, shewing the height of the pole and the shadow cast at 9 a.m., 12 noon and 3 p.m. respectively.

(*b*) With your protractor measure the angular height of the sun, and enter the same in the angles marked in the figures drawn (Fig. 24).

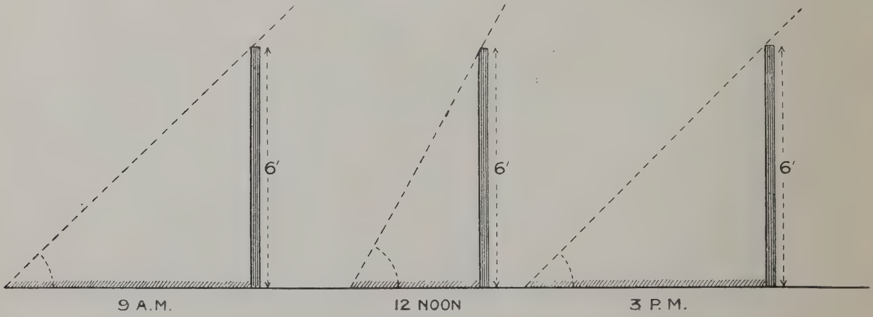

FIG. 24.

50. Graph shewing varying Lengths of Shadows.

From the results obtained in Ex. 48, make a graph shewing the relation between time of day and length of shadow cast by the pole.

To obtain a good result, the length of shadow should be measured at *every hour* from 9 a.m. to 4 p.m.

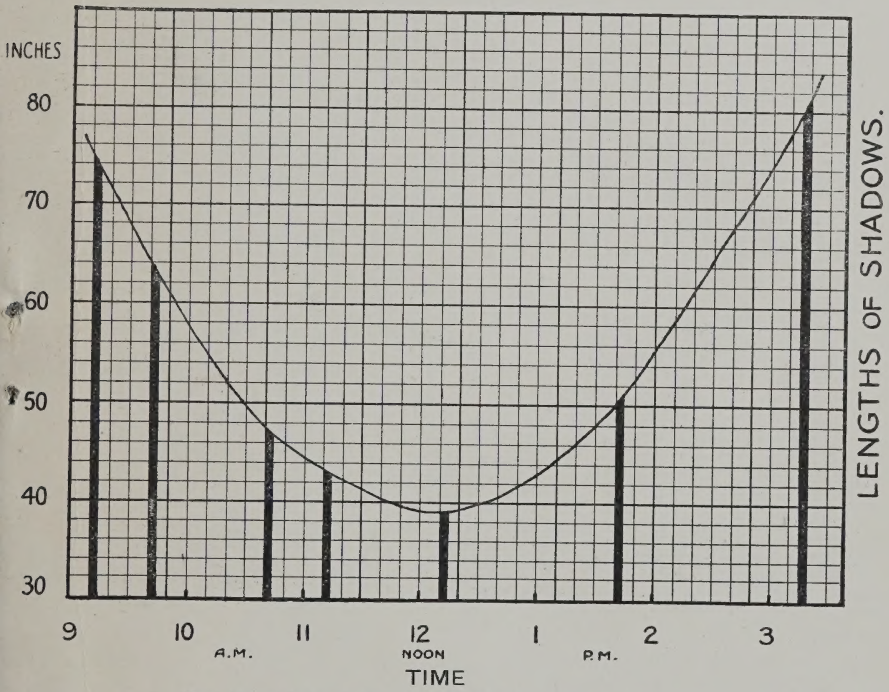

Fig. 25.—Graph shewing varying Lengths of Shadows.

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